

WHAT IS CLAIMED IS:

1 1. A method of separating CO₂ from a hydrocarbon gas inlet stream that is within
2 predetermined pressure and temperature ranges, comprising the steps of:

3 (a) subjecting the inlet stream to fractional distillation providing a CO₂ bottom
4 product stream and a distillation overhead stream;

5 (b) passing the distillation overhead stream to the inlet of a primary reflux drum
6 producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 (c) subjecting the hydrocarbon vapor stream from step (b) to membrane
8 separation to provide a hydrocarbon product stream and a permeate stream;

9 (d) compressing the permeate stream from step (c) to provide a compressed
10 permeate stream; and

11 (e) recycling the compressed permeate stream from step (d) to said inlet of said
12 primary reflux drum thereby providing a primary reflux liquid stream and a hydrocarbon
13 gas product vapor stream.

1 2. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 1
2 including:

3 passing said CO₂ bottom product stream from step (a) to a reboiler separator that
4 provides a reboiler separator vapor stream directed to a bottom portion of said distillation
5 column and a reboiler separator liquid stream.

1 3. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 2
2 wherein said CO₂ bottom product stream from step (a) is pumped at increased pressure to
3 said reboiler separator.

1 4. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 1,
2 including the step of passing at least a portion of said reboiler separator liquid stream
3 through a pressure reduction device to reduce the pressure thereof and adding heat thereto
4 to provide a CO₂ gas product.

1 5. A method of separating CO₂ from a hydrocarbon gas inlet stream that is within
2 predetermined pressure and temperature ranges comprising the steps of:

3 (a) subjecting the inlet stream to fractional distillation in a distillation column
4 providing a CO₂ bottom product stream and a distillation overhead stream;

5 (b) subjecting said distillation overhead stream of step (a) to membrane
6 separation, providing a hydrocarbon gas product stream and a permeate stream;

7 (c) compressing said permeate stream to provide a compressed permeate stream;
8 and

9 (d) refluxing said compressed permeate stream from step (c) back into said
10 distillation column.

1 6. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 5 in
2 which step (d) is carried out by refluxing said compressed permeate stream from step (c)

3 through a primary reflux drum having a primary reflux liquid stream outlet in
4 communication with said distillation column.

1 7. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 5,
2 including between steps (c) and (d) the additional step of passing said compressed
3 permeate stream through a secondary reflux drum.

1 8. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 5
2 including:
3 subjecting at least a portion of said CO₂ bottom product stream from step (a) to
4 reduced pressure to provide a CO₂ gas product.

1 9. A method of separating CO₂ from a hydrocarbon gas inlet stream according to claim 8
2 including the step of:
3 passing a portion of said CO₂ bottom product stream through a pressure reduction
4 device through at least one heat exchanger used to adjust the temperature range of said
5 hydrocarbon inlet stream.

1 10. A method of separating CO₂ from a hydrocarbon gas inlet stream that is within
2 predetermined pressure and temperature ranges, including the steps of:
3 (a) subjecting the inlet stream to a distillation column producing a bottom
4 product stream and a distillation overhead stream;
5 (b) condensing said distillation overhead stream of step (a) in a primary reflux
6 drum producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 (c) recycling said primary reflux liquid stream of step (b) to said distillation
8 column as a reflux stream;

9 (d) separating said concentrated hydrocarbon vapor stream from step (b) by
10 membrane separation into a hydrocarbon gas product stream and a permeate stream;

11 (e) compressing said permeate gas stream from step (d) to produce a
12 compressed permeate stream;

13 (f) condensing said compressed permeate stream of step (e) to produce a
14 primary reflux liquid stream that is conveyed to an upper portion of said distillation
15 column;

16 (g) pumping said bottom product stream from step (a) to provide an elevated
17 pressure liquid CO₂ product; and

18 (h) subjecting said bottom product stream of step (a) to a reboiler separator to
19 produce a CO₂ liquid product and a reboiler separator vapor stream that is recycled to a
20 bottom portion of said distillation column.

1 11. A system for separating CO₂ from a hydrocarbon gas inlet stream that is within
2 predetermined pressure and temperature ranges, comprising:

3 a distillation column receiving the hydrocarbon gas inlet stream and providing a
4 CO₂ bottom product stream and a distillation overhead stream;

5 a primary reflux drum having an inlet receiving the distillation overhead stream
6 and producing a primary reflux liquid stream and a hydrocarbon vapor stream;

7 a membrane unit receiving the hydrocarbon vapor stream from said primary
8 reflux drum to provide a hydrocarbon gas product stream and a permeate stream;

9 a compressor receiving said permeate stream from said membrane unit to provide
10 a compressed permeate stream; and
11 piping to recycle said compressed permeate stream to said inlet of said primary
12 reflux drum thereby providing a liquefied CO₂ product and a hydrocarbon gas product.

1 12. A system of separating CO₂ from a hydrocarbon gas inlet stream according to claim 11
2 including:

3 a reboiler separator having an inlet that receives said CO₂ bottom product stream
4 from said distillation column and that provides a reboiler separator vapor stream to a
5 bottom portion of said distillation column and a CO₂ liquid product.

1 13. A system for separating CO₂ from a hydrocarbon gas inlet stream according to claim 11
2 including;

3 a CO₂ bottom product pump in line with said CO₂ bottom product stream to
4 increase the pressure within said reboiler separator.

1 14. A system of separating CO₂ from a hydrocarbon gas inlet stream according to claim 11
2 including a primary refrigerant pressure reduction device through which at least a portion
3 of said CO₂ liquid product from said reboiler separator is passed to reduce the pressure
4 thereof and add heat thereto to provide a CO₂ gas product.

1 15. A system for separating CO₂ from a hydrocarbon gas inlet stream that is within
2 prescribed pressure and temperature ranges comprising:

3 a distillation column for receiving and fractionally distilling the hydrocarbon gas
4 inlet stream providing a CO₂ liquid product and a distillation overhead stream;

5 a membrane unit receiving the distillation overhead stream and providing a
6 hydrocarbon gas product and a permeate stream;

7 a compressor receiving the permeate stream and providing a compressed permeate
8 stream; and

9 a primary reflux drum receiving said compressed permeate stream providing a
10 primary reflux liquid stream that is refluxed back into said distillation column.

1 16. A system for separating CO₂ from a hydrocarbon stream according to claim 15 including
2 a secondary reflux drum that receives said compressed permeate stream and that provides
3 a secondary reflux liquid stream that is refluxed to said distillation column.

1 17. A system for separating CO₂ from a hydrocarbon stream according to claim 15 including
2 a primary refrigerant pressure reduction device through which at least a portion of said
3 CO₂ bottom product stream is passed to reduce the pressure thereof to provide a CO₂ gas
4 product.

1 18. A system for separating CO₂ from a hydrocarbon inlet stream according to claim 17
2 including an inlet cross heat exchanger through which said CO₂ gas product from said
3 refrigerant pressure reduction device passes and through which the hydrocarbon inlet
4 stream passes to thereby serve to adjust the temperature range of the hydrocarbon inlet
5 stream.